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(71) Applicant: 000100768
Aisin AW Co., Ltd.
10 Takani, Fujii-machi,
Anjo-shi, Aichi-ken

(72) Inventor: Katsuji Tanizaki
10 Takani, Fujii-machi,
Anjo-shi, Aichi-ken

(72) Inventor: Masashi Nakamura
same address

(72) Inventor: Shigeo Tsuzuki
same address

(74) Agent: Takayoshi Matsunaga
(and 1 other)

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(54) [Title of the Invention] Fuel Cell

(57) [Summary]

[Object] .To provide a fuel cell that can operate under variable loads with favorable response, and which completely blocks permeation of fuel with electrolyte during stoppage.

[Constitution] The device has a shutter mechanism formed in the shape of plates with small holes in the fuel chamber and/or air chamber, thereby controlling the amount of fuel and or air supplied to the electrode, as desired.

[Claims]

[Claim 1] A fuel cell having an electrolyte chamber between an air reducing electrode and fuel oxidizing electrode respectively provided with collection plates, an air chamber provided with an air supply/exhaust passage that exhausts air after supplying [it] to the air reducing electrode and a fuel chamber provided with a fuel supply/exhaust path that exhausts fuel after supplying [it] to the fuel oxidation electrode, said fuel cell characterized in that a slidable shutter plate having a plurality of passage holes is provided in the interfacial section between the fuel chamber or air chamber and the electrodes that are adjacent to each of the chambers, and, in the collector plate, a plurality of passage holes similar to the passage holes of the shutter plate having a shape that corresponds to each of the holes of said plurality of passage holes of said shutter plate are formed, disposed adjacent to said shutter plate.

[Detailed Description of the Invention]

[0001]

[Technological Field of the Invention] The present invention relates to a fuel cell, and specifically relates to a fuel cell that is highly responsive to load fluctuation.

[0002] Fuel such as methanol is supplied to a negative electrode (referred to below as fuel oxidation electrode) and air is supplied to a positive electrode (referred to below as air reduction electrode) on the opposite side of the negative electrode via electrolyte. With these types of fuel cells, electrons, protons and CO_2 gas are generated by the reaction between water and fuel such as methanol that are supplied. The electrons generated at the fuel oxidation electrode are supplied to the load side via a collector plate.

[0003] In addition, at the air reduction electrode, water is generated from air, the protons that are supplied from the electrolyte and the electrons that are supplied to the air reduction electrode, with a load interposed.

[0004] In this manner, an electrochemical fuel reaction occurs using a fuel such as methanol, and the free energy change accompanying this oxidation reaction is directly utilized as electrical energy.

[0005] A detailed diagram of the various electrodes is presented in Fig. 5. In the figure, a fuel oxidation electrode **33** consisting of a collector **39**, a gas supply layer **33a** formed from of fuel in

gaseous form and an oxidation reaction layer **33b** consisting of fuel is adjacent to a fuel chamber **32**. Similarly, an air reduction electrode **36** which consists of a collector **39**, a gas supply layer **36a** and an air reduction reaction layer **36b** is adjacent to and air chamber **37**, with an electrolyte chamber **35** present between the two electrodes **33** and **36**. The collector **39** is constituted by a mesh-form metal material. The gas supply layers **33a** and **36a** of the two electrodes **33** and **36** are provided for regulation so that the fuel such as methanol does not directly reach the reaction layers **33b** and **36b**. The layers are composed, for example of carbon clusters that are hydrophobic and have diameters of about 400 Å. In addition, the reaction layers **33b** and **36b** of the two electrodes **33** and **36** are the regions where the gaseous fuel or air react. In order to increase wetting of the electrolyte of the adjacent electrolyte chamber (containing sulfuric acid aqueous solution having a concentration of, for example, a few tens of a percent), hydrophilic carbon, for example, is given the form of clusters. Fuel oxidation reaction catalyst such as alloy of Pt and Ru is present in the reaction layer **33b** on the side of the fuel chamber **32**, and air reduction catalyst such as Pt is contained in the reaction layer **36b** on the side of the air chamber **37**.

[0006] The gas supply layers **33a** and **36a** of the respective electrodes **33** and **36** are provided with a function whereby oxygen gas or gasified methanol is supplied, a function whereby leakage of electrolyte to the side of the fuel chamber **32** is blocked, and an exhaust function for exhausting gas generated by the cell reaction at the reaction layers **33b** and **36b**. In addition, catalyst is contained in the reaction layers **33b** and **36b** and has a function whereby cellular reactions are carried out.

[0007]

[Problems to Be Solved by the Invention] Conventional fuel cells involving back-surface fuel supply can operate under steady-state conditions, but there are problems with their inability to operate under variable loads. A countermeasure to load fluctuation that has been conceived in the past is to control the amount and concentration of fuel that is supplied. However, problems remain such as increasing sizes of auxiliary equipment and deficiencies in response and accuracy of regulation.

[0008] In addition, there is the problem that fuel such as methanol passes through the electrolyte chamber **35** and diffuses towards the air reduction electrode **36**. In particular, if fuel diffuses in

large quantities into the electrolyte chamber **35** during stoppage of the cell reactions, there is the danger of problems such as heat generation and loss of cell capacity at start-up.

[0009] Thus, an object of the present invention is to provide a fuel cell that can operate under variable loads with favorable response, and which completely blocks permeation of electrolyte with fuel during stoppage.

[0010]

[Means Used for Solving the Problems] The above object of the present invention is attained by the following configuration: specifically, a fuel cell having an electrolyte chamber between an air reducing electrode and fuel oxidizing electrode respectively provided with collection plates, an air chamber provided with an air supply/exhaust passage that exhausts air after supplying [it] to the air reducing electrode and a fuel chamber provided with a fuel supply/exhaust path that exhausts fuel after supplying [it] to the fuel oxidation electrode, where this fuel cell is characterized in that a slidable shutter plate having a plurality of passage holes is provided in the interfacial section between the fuel chamber or air chamber and the electrodes that are adjacent to each of the chambers, and, in the collector plate, a plurality of passage holes similar to the passage holes of the shutter plate having a shape that corresponds to each of the holes of said plurality of passage holes of said shutter plate are formed, disposed adjacent to said shutter plate.

[0011] The shutter driving method can involve a hydraulic or electric motor, ultrasonic motor, a piezoelectric element utilizing deformation resulting from voltage change, an electromagnet, a bimetal, a shape memory alloy or the like. In addition, the pore diameters of the passage holes in the shutter plate or collector plate may be a few millimeters. In addition, a corrosion-resistant material such as stainless steel or fluororesin is preferred for the material used in the shutter plate, and the thickness can be a few millimeters or less in order to ensure sufficient control.

[0012] The shutter plate can also be sandwiched by two collector plates provided with passage holes in order to maintain shutter plate rigidity.

[0013]

[Action and Effect of the Invention] The passage aperture surface area through which air or fuel can pass formed by the respective passage holes of the plurality of passage holes provided on the collector pate and the shutter plate can be varied by sliding of the shutter plate, allowing the amount of fuel supplied to the fuel reaction layer of the electrode or the amount of air supplied to the air reaction layer to be controlled with favorable response. During stoppage of

the fuel cell reactions, the passage aperture surface area produced by the passage holes of the shutter plate and collector plate is decreased to zero, thereby preventing diffusion of fuel into the air reduction electrode via the electrolyte chamber.

[0014] Passage holes are provided on the shutter plate and collector plate in this manner, and the supplied amount of air and fuel is controlled by changing the passage aperture surface area produced by the two [sets of] passage holes, thus allowing the cell reaction to respond well to load variation.

[0015] In addition, during stoppage of the cell reaction, the aforementioned passage aperture surface area is decreased to zero, so there is no danger of fuel diffusing to the side of the air reduction electrode and no danger of reduction in cell performance, generation of heat or the like.

[0016]

[Working Examples] Working examples of the present invention are described below in reference to the figures.

Working Example 1

A vertical sectional view of the fuel cell **1** is presented in Fig. 1, and a side sectional view of the fuel chamber of Fig. 1 is presented in Fig. 2. A shutter **7** provided with a plurality of passage holes **6** along with a collector plate **10** provided with passage holes **8** of the same surface area and pitch as the passage holes **6** of the shutter plate **7** are provided on the fuel oxidation electrode **3** and air reduction electrode **5**.

[0017] An electrolyte chamber **12** is provided between the two collector plates **10**, **10** with a gas supply layer and reaction layer **11** interposed. The shutter plates **7**, **7** can be moved upwards and downwards by means of a motor **16** (Fig. 2) via a cam **15** provided in a lower chamber **14** of the fuel cell. A one-way clutch **19** is provided on the linkage shaft **18** of the cam **15** and the motor **16**, and by rotation of the cam **15** in just one direction, it is possible to hold the shutter plate **7** in an intermediate position, even when the motor **16** is off. By means of vertical movement of the shutter **7**, the passage aperture surface area produced by the passage holes **8** of the collector plate **10** and the passage holes **6** of the shutter plate **7** can be varied, and flow of air or fuel such as methanol can be controlled.

[0018] In addition, during stoppage of the cell reaction, the passage aperture surface area between the aforementioned passage holes **6** and **8** is decreased to zero, thereby preventing improper diffusion of fuel through the electrolyte chamber **12** towards the air reduction electrode **5**. The end of the shutter plate **7** is sealed with a sealing member **20** for the fuel cell wall surface. In addition, the left half of Fig. 2 shows the passage aperture when open, whereas the right half shows the condition of the passage aperture when closed.

[0019] Working Example 2

The fuel cell **1** of this working example is presented in Fig. 3 and Fig. 4. In this working example, a dividing wall **23** in which multiple passage holes **22** are formed is provided at the boundary between the fuel chamber **21** and fuel oxidation electrode **3**, and a freely rotating shutter plate **25** is supported on a center shaft on this dividing wall **23.** Holes **26** having the same surface area and the same pitch as the holes of the dividing wall **23** are formed in this shutter plate **25**. The shutter plate **25** is rotated by an extended rack **27** that is rotated by a pinion **30** that is driven by a motor **29**.

[Brief Description of the Figures]

[Fig. 1] Sectional view of the fuel cell of a working example of the present invention.

[Fig. 2] Partial sectional view from the front of the fuel cell of Fig. 1.

[Fig. 3] Sectional view of the fuel cell of another working example of the present invention.

[Fig. 4] Partial sectional view showing the fuel cell of the working example of Fig. 3 from the front.

[Fig. 5] Detailed diagram of the respective electrodes of the fuel cell.

[Key]

3 Fuel cell oxidation electrode

5 Air reduction electrode

7 Shutter plate

10 Collector

6, 8, 22, 26 Holes

7, 25 Shutter plates

[Fig. 1]

Fuel Air

Fuel chamber | Electrolyte chamber | Air Chamber

Fuel Air

[Fig. 2]

Fuel

Fuel

Sealing member

Motor

[Fig. 3]

Fuel chamber | Electrolyte chamber | Air Chamber

Fuel Air

Damper (-) Electrode plate (+) Electrode plate

[Fig. 4]

29 Motor

close open

[Fig. 5]

Fuel chamber	Gas supply layer	Reaction layer	Electrolyte chamber	Reaction layer	Gas supply layer	Air chamber

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(72) Inventor: Hitoshi Dogoshi 10 Takani, Fujii-machi, Anjo-shi, Aichi-ken	(72) Inventor: Taizo Yamamoto Same address